

**U.S. DEPARTMENT OF ENERGY
DEPARTMENT-WIDE
FUNCTIONAL AREA QUALIFICATION STANDARD**

CIVIL/STRUCTURAL ENGINEERING QUALIFICATION STANDARD

Defense Nuclear Facilities Technical Personnel



**U.S. Department of Energy
Washington, D.C. 20585**

May 1995

Approval and Concurrence

The Associate Deputy Secretary for Field Management is the Management Sponsor for the Department-wide Civil/Structural Engineering Functional Area Qualification Standard. The Management Sponsor is responsible for reviewing the Qualification Standard to ensure that the technical content is accurate and adequate for Department-wide application. The Management Sponsor, in coordination with the Human Resources organization, is also responsible for ensuring that the Qualification Standard is maintained current. Concurrence with this Qualification Standard by the Associate Deputy Secretary for Field Management is indicated by the signature below.

The Technical Personnel Program Coordinator (TPPC) is responsible for coordinating the consistent development and implementation of the Technical Qualification Program throughout the Department of Energy. Concurrence with this Qualification Standard by the Technical Personnel Program Coordinator is indicated by the signature below.

The Technical Excellence Executive Committee (TEEC) consists of senior Department of Energy managers. This Committee is responsible for reviewing and approving the Qualification Standard for Department-wide application. Approval of this Qualification Standard by the Technical Excellence Executive Committee is indicated by the signature below.

NOTE: The signatures below reflect concurrence and approval of this Qualification Standard for interim Implementation. Final concurrence and approval will occur in December 1995, pending comments received based upon implementation.

CONCURRENCE:

Associate Deputy Secretary for
Field Management

Technical Personnel Program
Coordinator

APPROVAL:

Chairman
Technical Excellence Executive Committee

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FUNCTIONAL AREA QUALIFICATION STANDARD

FUNCTIONAL AREA

Civil/Structural Engineering

PURPOSE

The Technical Qualification Program is divided into three levels of technical competence and qualification. The General Technical Base Qualification Standard establishes the base technical competence required of all Department of Energy defense nuclear facility technical personnel. The Functional Area Qualification Standards build on the requirements of the General Technical Base Qualification Standard and establish Department-wide functional competence requirements in each of the identified functional areas. Office/facility-specific qualification standards establish unique operational competency requirements at the Headquarters or Field element, site, or facility level.

The Civil/Structural Engineering Functional Area Qualification Standard establishes common functional area competency requirements for all Department of Energy civil/structural engineering personnel who provide management oversight or direction impacting the safe operation of defense nuclear facilities. Satisfactory and documented completion of the competency requirements contained in this Standard ensures that technical employees possess the minimum requisite competence to fulfill their functional area duties and responsibilities. Additionally, these competency requirements provide the functional foundation to assure successful completion of the appropriate Office/facility-specific qualification standard.

APPLICABILITY

This Standard applies to all Department of Energy civil/structural engineering personnel who provide management direction or oversight impacting the safe operation of defense nuclear facilities. Personnel designated by Headquarters or Field element line management as participants in the Technical Qualification Program are required to meet the requirements of this Standard as defined in DOE Order 3410.

IMPLEMENTATION REQUIREMENTS

The competencies contained in the Standard are divided into the following four categories:

1. General Technical
2. Regulatory
3. Administrative
4. Management, Assessment, and Oversight

Each of the categories is defined by one or more competency statements indicated by bold print. The competency statements define the expected knowledge and/or skill that an individual must possess, and are requirements. Each competency statement is further explained by a listing of

supporting knowledge and/or skill statements. The supporting knowledge and/or skill statements are not requirements and do not necessarily have to be fulfilled to meet the intent of the competency.

The competencies identify a familiarity level, working level, or expert level of knowledge; or they require the individual to demonstrate the ability to perform a task or activity. These levels are defined as follows:

Familiarity level is defined as basic knowledge of or exposure to the subject or process adequate to discuss the subject or process with individuals of greater knowledge.

Working level is defined as the knowledge required to monitor and assess operations/activities, to apply standards of acceptable performance, and to reference appropriate materials and/or expert advice as required to ensure the safety of Departmental activities.

Expert level is defined as a comprehensive, intensive knowledge of the subject or process sufficient to provide advice in the absence of procedural guidance.

Demonstrate the ability is defined as the actual performance of a task or activity in accordance with policy, procedures, guidelines, and/or accepted industry or Department practices.

Headquarters and Field elements shall establish a program and process to ensure that all defense nuclear facility technical personnel required to participate in the Technical Qualification Program meet the competency requirements contained in this Standard. Documentation of the completion of the requirements of this Standard shall be included in the employee's training and qualification record.

In select cases, it may be necessary to exempt an individual from completing one or more of the competencies in this Functional Area Qualification Standard. Exemptions from individual competencies shall be justified and documented in accordance with DOE Order 3410. Exemptions shall be requested by the individual's immediate supervisor, and approved one level above the individual's immediate supervisor.

Equivalencies may be granted for individual competencies based upon an objective evaluation of the employee's prior education, experience, and/or training. Documentation of equivalencies shall indicate how the competency requirements have been met. The supporting knowledge and/or skill statements may be considered when evaluating an individual's ability with respect to each competency requirement.

Training shall be provided to employees in the Technical Qualification Program who do not meet the competencies contained in the qualification standard. Departmental training will be based upon supporting knowledge and/or skill statements similar to the ones listed for each of the competency statements. Headquarters and Field elements should use the supporting knowledge and/or skill statements as a basis for evaluating the content of any training courses used to provide individuals with the requisite knowledge and/or skill required to meet the qualification standard competency statements.

DUTIES AND RESPONSIBILITIES

The following are duties and responsibilities normally expected of defense nuclear facility technical personnel assigned to the civil/structural engineering functional area:

- A. Provide technical reviews of civil/structural design documents, including assessment of the economics of operations, throughout the facility life cycle.
- B. Provide oversight of contractor operations and maintenance of facilities related to civil/structural activities.
- C. Perform preliminary hazard assessments to determine related civil/structural Safety Analysis Report requirements, and review the facility Safety Analysis Reports.
- D. Provide technical advice to management and other organizations both internal and external to the Department.
- E. Write/review/comment on Department policy and procedures and/or review contractor procedures pertaining to civil/structural design, operations, and/or construction.
- F. Participate in the acquisition process for technical and construction services.
- G. Perform oversight and surveillance of construction activities.
- H. Participate in Department and industry conferences, symposia, etc.
- I. Develop and present proposals for approval covering facility planning, design, construction, and maintenance consistent with Department and Federal requirements (i.e., Conceptual Design Reports, Vulnerability Assessments, National Environmental Protection Act, and Environmental Impact Statements).

Additional duties and responsibilities specific to the site, facility, operational activities, and/or other involved organizations shall be contained in the facility-specific qualification standard(s).

BACKGROUND AND EXPERIENCE

The U. S. Office of Personnel Management's Qualification Standards Handbook establishes minimum education, training, experience, or other relevant requirements applicable to a particular occupational series/grade level, as well as alternatives to meeting specified requirements.

The preferred education, experience, and certification for civil/structural engineering personnel is:

1. Education:

Bachelor of Science degree in Civil Engineering or meeting the alternative requirements specified for civil engineers in the Qualifications Standards Handbook.

2. Experience:

Industrial, military, Federal, State or other directly related public or private background that has provided specialized experience in civil engineering. Specialized experience can be demonstrated through possession of the competencies outlined in this Standard.

3. Certification

Registered as a professional engineer in any state or jurisdiction.

REQUIRED COMPETENCIES

The competencies contained in this Standard are distinct from those competencies contained in the General Technical Base Qualification Standard. All civil/structural engineering personnel must complete the competency requirements of the General Technical Base Qualification Standard prior to or in parallel with the completion of the competency requirements contained in this Standard. Each of the competency statements defines the level of expected knowledge and/or skills that an individual is required to possess to meet the intent of this Standard. The supporting knowledge and/or skill statements further describe the intent of the competency statements but are not requirements.

1. GENERAL TECHNICAL

1.1 Civil/structural engineering personnel shall demonstrate a familiarity level knowledge of chemistry fundamentals of corrosion.

Supporting Knowledge and/or Skills

- a. Explain the process of general corrosion of iron and steel when exposed to water.
- b. Discuss the two conditions that can cause galvanic corrosion.
- c. Discuss the following types of specialized corrosion:
 - Pitting corrosion
 - Stress corrosion cracking
 - Crevice corrosion
- d. Explain the ion exchange process.

1.2 Civil/structural engineering personnel shall demonstrate a familiarity level knowledge of the fundamentals of chemical safety .

Supporting Knowledge and/or Skills

- a. Discuss the hazards associated with the use of corrosives (acids and alkalies).
- b. Describe the general safety precautions necessary for the handling, storage, and disposal of corrosives.
- c. Discuss the general safety precautions regarding toxic compounds.
- d. Describe the criteria used to determine if a compound is a health hazard and discuss the methods by which toxic compounds may enter the body.
- e. Discuss the general safety precautions regarding the use, handling, and storage of compressed gases, specifically including: hydrogen, oxygen, and nitrogen.
- f. Discuss the safety precautions for working with cryogenic liquids.
- g. Explain the difference between a flammable material and a combustible material.
- h. Describe the general safety precautions regarding the use, handling, and storage of flammable and combustible materials.

1.3 Civil/structural engineering personnel shall demonstrate a familiarity level knowledge of the concepts, theories, and principles of the properties of materials.

Supporting Knowledge and/or Skills

- a. State the five types of bonding that occur in materials and their characteristics.
- b. Describe the characteristics of the following crystal structures:
 - Body-centered cubic structure
 - Face-centered cubic structure
 - Hexagonal close-packed structure
- c. Identify and describe the crystalline structure of a metal.
- d. Define the following terms:
 - Grain structure
 - Creep
 - Polymorphism
 - Grain boundary
 - Alloy
 - Grain

1.4 Civil/structural engineering personnel shall demonstrate a familiarity level knowledge of problem-solving in probability and simple statistics.

Supporting Knowledge and/or Skills

- a. State the definition of the following statistical terms:
 - Mean
 - Variance
 - Mean variance
 - Median
 - Mode
- b. Explain the structure and function of a bell curve.
- c. Calculate the mathematical mean of a given set of data.
- d. Calculate the mathematical mean variance of a given set of data.
- e. Given the data, calculate the probability of an event.

1.5 Civil/structural engineering personnel shall demonstrate a working level knowledge of English and SI system units of measurement and conversion.

Supporting Knowledge and/or Skills

- a. Define the three fundamental dimensions: length, mass, and time.

- b. List standard units of the fundamental dimensions for each of the following systems:
 - International System of Units (SI)
 - English System
 - c. Differentiate between fundamental and derived measurements.
 - d. Given appropriate conversion tables, convert between English and SI units of length.
 - e. Given appropriate conversion tables, convert between English and SI units of mass.
- 1.6 Civil/structural engineering personnel shall demonstrate a working level knowledge of applying the principles of force to stationary or moving objects.**

Supporting Knowledge and/or Skills

- a. Define the following:
 - Force
 - Weight
- b. State the purpose of a free-body diagram.
- c. Given all necessary information, construct a free-body diagram.
- d. State the conditions necessary for a body to be in force equilibrium.
- e. Define the following:
 - Equations of condition
 - Internal force
 - Tensile force
 - Compressive force
 - Net force
 - Frictional force
 - Axial force
 - Shear force

- Consistent joint forces
- Artificial joint forces

f. Define the following:

- Compound truss
- Complex truss
- Space truss
- Bending moment
- Deflection
- Side-sway
- Cut-back structure
- Statically indeterminate structure

g. Explain the difference between a static-friction force and a kinetic-friction force.

h. State two factors that affect the magnitude of friction force.

i. Explain the difference between centripetal force and centrifugal force.

1.7 Civil/structural engineering personnel shall demonstrate a working level knowledge of the basic principles and concepts of geotechnical science.

Supporting Knowledge and/or Skills

- a. Identify and describe examples of shallow and deep foundations.
- b. Discuss two basic elements of embankment design.
- c. Define erosion and describe the characteristics and effects of water and wind erosion.
- d. Describe the types of tests used to determine the strength and dynamic properties of soils.
- e. Describe the unified soil classification system.
- f. Describe the following processes and explain how water and soil interact in each:
 - Infiltration and percolation
 - Groundwater recharge
 - Runoff
 - Moisture/density relationship
 - Unsaturated flow
 - Pore water pressure
- g. Discuss the applicability of active, passive, and at-rest pressures to earth-retaining structures.
- h. Define the following:

- Vertical geostatic stress
 - Horizontal geostatic stress
 - Bearing capacity
 - Soil compression
 - Primary consolidation
 - Secondary consolidation
 - Bearing piles
 - Tension piles
 - Caisson
- i. Explain Darcy's Law of Permeability.
- j. List the soil and site data required for a new structure.
- k. Given soil properties and the applicable Terzaghi formulation, calculate the ultimate bearing capacity of a soil.
- l. Given soil data, determine the factors that influence the soil volume and weight relationship.

1.8 Civil/structural engineering personnel shall demonstrate a working level knowledge of the basic principles and concepts of hydrology.

Supporting Knowledge and/or Skills

- a. Define hydrology as it applies to civil engineering.
- b. Describe the hydrologic cycle.
- c. Define the following hydrologic terms and describe the relationships between them:
- Precipitation
 - Stream flow
 - Evaporation
 - Transpiration
 - Subsurface water (groundwater)
 - Sedimentation
 - Vadose zone
 - Saturated zone
 - Attenuation
 - Dispersion
 - Permeability

- Porosity
- Conductivity

- d. Describe the flow of groundwater in the subsurface and discuss the importance of this to environmental restoration.

1.9 Civil/structural engineering personnel shall demonstrate a working level knowledge of the basic principles and concepts of geology.

Supporting Knowledge and/or Skills

- a. Discuss the following types of rocks, cite examples of each and how each one relates to water, vapor, or contaminant movement:
- Igneous
 - Sedimentary
 - Metamorphic
- b. Describe the elastic properties of rocks.
- c. Describe the strength properties of rocks.
- d. Describe the geometry and properties of the following rock masses and effects on contaminant movement:
- Folds
 - Faults
 - Structural discontinuities
 - Shear strength of discontinuities
 - Residual stress
 - Sheet joints
 - Fractures
- e. Discuss the use of geological and geotechnical maps.
- f. Describe a geomorphic system and cite an example.

1.10 Civil/structural engineering personnel shall demonstrate a working level knowledge of the Department design and construction processes.

Supporting Knowledge and/or Skills

- a. Discuss the accepted Department design process to include:
- Congressional project approval process
 - Criteria to prepare a conceptual design report (CDR)
 - Actual preparation of a CDR
 - Justification and validation report
 - Review and approval of design criteria
 - Architect/engineer (AE) selection process
 - Design approval process

- b. Discuss the Department construction process following a project's certification for construction.
 - Differentiate between direct-hire and indirect-hire construction contracts.
 - Discuss the role of Department civil/structural engineering personnel in the construction process.
- 1.11 Civil/structural engineering personnel shall demonstrate a working level knowledge of the principles associated with surveying, grading, drainage, and paving.**

Supporting Knowledge and/or Skills

- a. Discuss the basics of surveying practices.
 - b. Read and interpret a site contour map.
 - c. Given field notes and data, draw a contour map.
 - d. Read and interpret a site plan drawing (old contour, new contour).
 - e. Define the following terms as they relate to horizontal curves:
 - Point of intersection (PI),
 - Point of tangency (PT),
 - Point of curvature (PC)
 - f. Using field data, prepare a site grading plan.
 - g. Define, compare, and contrast the following terms:
 - Balance and cut-and-fill
 - Shrink and swell
 - h. Discuss the characteristics of rigid and flexible pavement.
 - i. Discuss the hydraulics associated with drainage to include:
 - Open channel flow
 - Flood zone determination
- 1.12 Civil/structural engineering personnel shall demonstrate a working level knowledge of the principles and concepts of structural analysis.**

Supporting Knowledge and/or Skills

- a. Identify and discuss the various methods of structural analysis.
- b. Discuss the purpose of shear and moment diagrams.
- c. Discuss the fundamentals of the finite element method of structural analysis.
- d. Discuss the differences between the flexibility and stiffness methods of structural analysis.
- e. Discuss the differences between the elastic and plastic methods of structural analysis.

1.13 Civil/structural engineering personnel shall demonstrate a working level knowledge of the fundamentals of reinforced concrete design.

Supporting Knowledge and/or Skills

- a. Identify and discuss the minimum building code requirements for reinforced concrete as contained in the American Concrete Institute (ACI) document ACI-318, Building Code Requirements for Reinforced Concrete.
- b. Discuss the longitudinal and shear reinforcement requirements for beam design.
- c. Discuss the basics of the following:
 - Cast-in-place concrete
 - Pre-stressed concrete
 - Post-tension concrete
 - Tilt-up concrete
 - Structure design

1.14 Civil/structural engineering personnel shall demonstrate a working level knowledge of the principles of structural steel design.

Supporting Knowledge and/or Skills

- a. Identify and discuss the minimum building code requirements for structural steel as contained in the following American Institute of Steel Construction (AISC) documents:
 - AISC M011, Manual of Steel Construction
 - AISC N690, Nuclear Facilities: Steel Safety-Related Structures for Design, Fabrication, and Erection
- b. Explain the difference between allowable stress design (ASD) and load resistance factor design (LRFD).
- c. Given data, analyze a steel beam and determine its compliance with American Institute of Steel Construction requirements.

- d. Given data for a steel column, analyze the column and determine its compliance with American Institute of Steel Construction requirements.
- e. Sketch and explain the stress-strain curve for steel.
- f. Define the following:
 - Minimum edge distance
 - Unbraced length
 - Beam bearing plate
 - Web crippling
- g. Given data and the appropriate equations, calculate the following for a steel member:
 - Average shear stress
 - Parabolic shear stress
 - Bending stress
 - Axial stress
 - Torsional shear stress
- h. List the causes of buckling of load bearing columns.
- i. Describe the following types of connections:
 - Friction
 - Bearing
 - Tension
 - Rigid
 - Non-rigid
 - Semi-rigid

1.15 Civil/structural engineering personnel shall demonstrate a working level knowledge of the principles and characteristics of natural phenomena as related to structures.

Supporting Knowledge and/or Skills

- a. Discuss the impact on facilities and the mitigating factors associated with the following hazards:
 - Flooding
 - Wind
 - Tornado
 - Earthquake and/or other seismic events on facilities
- b. Describe the safety measures and design features commonly used as safeguards against natural hazards.
- c. Discuss the requirements related to earthquake load design that are stipulated in Department of Energy (DOE) Order 6430.1A, General Design Criteria, for

Department facilities used for radioactive material handling, processing, or storage.

- d. Describe the use of the following University of California Research Laboratory (UCRL) documents in determining the design requirements for structural wind, tornado, and earthquake loading:
 - UCRL 15910, Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena
 - UCRL 53526, Natural Phenomena Hazards Modeling Project, Extreme Wind/Tornado Hazard Models for Department of Energy Sites
 - UCRL 53582, Natural Phenomena Hazards Modeling Project, Seismic Hazard Models for Department of Energy Sites

1.16 Civil/structural engineering personnel shall demonstrate a working level knowledge of seismic analysis fundamentals.

Supporting Knowledge and/or Skills

- a. Given data characterizing the stiffness and mass, evaluate the frequency and modal shapes.
- b. Explain the significance of a design response spectra.
- c. Discuss how floor response spectra are evaluated.
- d. Discuss the role of damping and how it affects structural response.
- e. Discuss the time-history and modal response methods of analysis.
- f. Discuss the importance of ductility and how it is achieved in:
 - A reinforced concrete structure.
 - A steel structure.
- g. Discuss the parameters that determine when soil structure interaction effects are significant.

1.17 Civil/structural engineering personnel shall demonstrate a working level knowledge of the fundamentals and principles associated with hydraulics.

Supporting Knowledge and/or Skills

- a. Define the following:
 - Dynamic viscosity
 - Kinematic viscosity
 - Specific volume
 - Specific gravity
 - Capillarity
 - Cavitation
 - Hoop tension
 - Laminar flow
 - Turbulent flow
 - Uniform flow
- b. Discuss the differences between Newtonian and non-Newtonian flow.
- c. Describe the bulk modulus of elasticity and compressibility.
- d. Describe the effects characterized by Pascal's Law of Fluid Pressure.
- e. Explain the equation of continuity as it applies to fluid flow.
- f. Describe Reynold's number and how it is used.
- g. Discuss pressurized and unpressurized flow.

1.18 Civil/structural engineering personnel shall demonstrate the ability to perform fundamental hydraulic calculations.

Supporting Knowledge and/or Skills

- a. Given data, conduct a piping network analysis.
- b. Given data and the Bernoulli equation, calculate fluid velocities, pressure changes, and elevation differences.
- c. Given data, size a pump for a particular application.

1.19 Civil/structural engineering personnel shall demonstrate the ability to analyze potable and waste water treatment systems.

Supporting Knowledge and/or Skills

- a. Discuss the following methods of waste water treatment:
 - Primary
 - Secondary
 - Tertiary
- b. Given waste water chemistry data, analyze the data and determine the treatment of the effluent necessary for compliance with the National Pollutant

Discharge Elimination System (NPDES) requirements with the following parameters as a minimum:

- Biological oxygen demand (BOD)
- Chemical oxygen demand (COD)
- Total dissolved solids (TDS)
- pH
- PH

- c. Given water chemistry data, analyze the data and determine the treatment needed to bring it into drinking water standards.

1.20 Civil/structural engineering personnel shall demonstrate a familiarity level knowledge of the various computer applications used in civil engineering.

Supporting Knowledge and/or Skills

- a. Identify and discuss at least one of the major computer codes used in structural analysis.
- b. Describe the applications of computer-aided design (CAD) as it relates to civil/structural engineering design functions (e.g., grading, drainage, paving, piping network analysis, structural analysis).

1.21 Civil/structural engineering personnel shall demonstrate the ability to use civil engineering plans and drawings.

Supporting Knowledge and/or Skills

- a. Given a site plan, identify elevations, soil and rock probes, and contours.
- b. Given a utility plan, identify sewer, potable water, gas, power, and fire-suppression lines.
- c. Given architectural or structural plans or details, describe the key features in the design and explain the symbols used.
- d. Given a specification package and a set of drawings, analyze the drawings to verify that the specifications have been met.

2. REGULATORY

NOTE: When Department of Energy (DOE) directives are referenced in the qualification standard, the most recent revision should be used.

2.1 Civil/structural engineering personnel shall demonstrate a working level knowledge of the civil/structural engineering-related sections and/or requirements of the following related Department of Energy (DOE) Orders:

- **DOE Order 5480.28, Natural Phenomena Hazards Mitigation**
- **DOE Order 6430.1A, General Design Criteria, Section B, Uniform Building Code (UBC)**

Supporting Knowledge and/or Skills

- a. Describe the purpose, scope, and application of the requirements detailed in the above Orders.
- b. Discuss the graded approach process by which Department line management determines an appropriate level of coverage by civil/structural engineers. Include in this discussion factors that may influence the level of coverage.
- c. Discuss what constitutes acceptable contractor work performance consistent with the requirements of the above Orders.

2.2 Civil/structural engineering personnel shall demonstrate the ability to determine the adequacy of local compliance with the civil/structural engineering-related sections and/or requirements of the following Department of Energy (DOE) Orders:

- **DOE Order 5480.28, Natural Phenomena Hazards Mitigation**
- **DOE Order 6430.1A, General Design Criteria, Section B, Uniform Building Code (UBC)**

Supporting Knowledge and/or Skills

- a. Using the above Orders, prepare an action plan which adequately outlines interviews and observations to be conducted, and details documents to review during an evaluation of contractor compliance with the requirements of these Orders.
- b. Using an appropriate level of coverage, conduct an evaluation of contractor compliance with the requirements of the Orders. During this evaluation, demonstrate the ability to properly conduct interviews, observations, and document reviews.
- c. Given data from an evaluation, analyze the results of the evaluation to determine contractor compliance or noncompliance with the requirements.

- d. Given the results from an analysis of contractor compliance or noncompliance, document the results and communicate them to contractor and Department line management.

2.3 Civil/structural engineering personnel shall demonstrate a working level knowledge of the following civil/structural engineering-related Department of Energy (DOE) Technical Standards:

- DOE-STD-1020-94, Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities
- DOE-STD-1021-93, Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components
- DOE-STD-1022-94, Natural Phenomena Hazards Site-Characterization Criteria
- DOE-STD-1024-92, Guidelines for Use of Probabilistic Seismic Hazards Curves at DOE Sites

Supporting Knowledge and/or Skills

- a. Describe the purpose, scope, and application of the requirements detailed in the listed technical standards.
- b. Discuss the graded approach process by which Department line management determines an appropriate level of coverage by civil/structural engineers. Include in this discussion factors that may influence the level of coverage.
- c. Discuss what constitutes acceptable contractor work performance consistent with the requirements of the above orders.
- d. Discuss how hazard and accident analyses are used for structures, systems, and components.
- e. Compare and contrast the following terms:
 - Safety class
 - Safety significance
 - Safety-related

2.4 Civil/structural engineering personnel shall demonstrate the ability to evaluate the adequacy of local compliance with the following civil/structural engineering-related Department of Energy (DOE) Technical Standards:

- DOE-STD-1020-94, Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities
- DOE-STD-1021-93, Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components
- DOE-STD-1022-94, Natural Phenomena Hazards Site-Characterization Criteria
- DOE-STD-1024-92, Guidelines for Use of Probabilistic Seismic Hazards Curves at DOE Sites

Supporting Knowledge and/or Skills

- a. Using two technical standards, prepare an action plan which adequately outlines interviews and observations to be conducted, and details documents to review during an evaluation of contractor compliance with the requirements of the selected technical standards.
- b. Using an appropriate level of coverage, conduct an evaluation of contractor compliance with the requirements of the selected technical standards. During this evaluation, demonstrate the ability to properly conduct interviews, observations, and document reviews.
- c. Given data from an evaluation, analyze the results of the evaluation to determine contractor compliance or noncompliance with the requirements.
- d. Given the results from an analysis of contractor compliance or noncompliance, document and communicate the results to contractor and Department line management.

2.5 Civil/structural engineering personnel shall demonstrate a familiarity level knowledge of the Occupational Safety and Health Act (OSHA).

Supporting Knowledge and/or Skills

- a. Discuss how the Occupational Safety and Health Act applies to and impacts Department civil/structural engineering programs.
- b. Identify the requirements contained in the Occupational Safety and Health Act that form the basis of authority for civil/structural engineering personnel in the oversight and management of Department facilities.

2.6 Civil/structural engineering personnel shall demonstrate a familiarity level knowledge of the architectural engineering requirements outlined in the following documents as applicable to the review of design specifications for Department of Energy (DOE) facilities:

- **Americans with Disabilities Act (ADA)**
- **General Services Administration (GSA) Space Requirements**
- **Life Safety Codes**

Supporting Knowledge and/or Skills

- a. Discuss the basics for the design codes related to the Americans with Disabilities Act as they pertain to civil/structural engineering.
- b. Identify and discuss the General Services Administration space requirements.
- c. Identify and discuss the life safety codes.

2.7 Civil/structural engineering personnel shall demonstrate a working level knowledge of the civil/structural engineering-related requirements and inter-

relationship of Department of Energy (DOE) Order 5480.22, Technical Safety Requirements, and DOE Order 5480.23, Nuclear Safety Analysis Reports.

Supporting Knowledge and/or Skills

- a. Discuss the purpose of the Orders and the roles and responsibilities applicable to civil/structural engineering personnel.
- b. Identify the purpose of, and discuss the basic content elements of a Safety Analysis Report (SAR).
- c. Discuss the general approval process for the Safety Analysis Report, identifying the specific elements related to the civil/structural engineering review.
- d. Identify the purpose of, and discuss the elements of Technical Safety Requirements (TSR).
- e. Discuss the relationship between the Safety Analysis Report and Technical Safety Requirements.
- f. Discuss the civil/structural engineering related conditions that can lead to determination of an inadequate safety analysis.
- g. If an inadequate safety analysis is determined, identify required actions.

3. ADMINISTRATIVE

3.1 Civil/structural engineering personnel shall demonstrate a familiarity level knowledge of methods to maintain communications with Headquarters, Field elements and the public.

Supporting Knowledge and/or Skills

- a. Describe the Department's organization and discuss the procedures for communicating between elements.
- b. Describe the Department's procedures and policy for communicating with other agencies.

4. MANAGEMENT, ASSESSMENT, AND OVERSIGHT

NOTE: When Department of Energy (DOE) directives are referenced in the qualification standard, the most recent revision should be used.

4.1 Civil/structural engineering personnel shall demonstrate a working knowledge of the Department of Energy (DOE)/facility contract provisions necessary to provide oversight of a contractor's operations.

Supporting Knowledge and/or Skills

- a. Describe the role of civil/structural engineering personnel in contractor oversight.
- b. Compare and contrast the following:
 - The Department of Energy's expectations of a Management and Operating (M&O) contractor
 - Management and Operating (M&O) contractors' expectations of the Department of Energy
- c. Identify the key elements and features of an effective Department of Energy and Management and Operating (M&O) contractor relationship.
- d. Describe civil/structural engineering personnel's responsibility in contractor compliance with the Price-Anderson Amendments Act.
- e. Describe the role of civil/structural engineering personnel in the cost-plus-award fee process.
- f. Participate in a cost-plus-award fee evaluation for one grading period.
- g. Explain civil/structural engineering personnel's responsibilities in identifying, reporting, reviewing, and documenting employee concerns under DOE Order 5480.29, Employee Concerns.

4.2 Civil/structural engineering personnel shall demonstrate a working level knowledge of assessment techniques, reporting, and follow-up actions as applied to contractor performance.

Supporting Knowledge and/or Skills

- a. Describe civil/structural engineering personnel's role in performance oversight of Government-Owned, Contractor-Operated (GOCO) facilities.
- b. Describe the assessment requirements and limitations of civil/structural engineering personnel interfacing with contractor employees.
- c. Describe how planning, observing, interviewing, and document research are used during an assessment.

- d. Explain the essential elements of a performance-based assessment including the areas of investigation, fact-finding, and reporting. Include a discussion of the essential elements and processes associated with the following assessment activities:
 - Exit interviews
 - Closure process
 - Tracking to closure
 - Follow-up
 - Contractor corrective action implementation
- e. Describe the actions to be taken if the contractor challenges the assessment findings and explain how such challenges might be avoided.

4.3 Civil/structural engineering personnel shall demonstrate the ability to independently assess contractor and/or Federal employee civil/structural engineering activities and make all necessary reports.

Supporting Knowledge and/or Skills

- a. Given different sets of performance data, compare and contrast the data to highlight acceptable and unacceptable work performance.
- b. Describe the methods by which noncompliance is determined and communicated to contractor and Department management.
- c. Conduct two assessments of a contractor's civil/structural engineering activities and develop and submit the resulting assessment report.
- d. Using the findings from an assessment, develop an assessment report.
- e. Participate in formal meetings between Department management and senior contractor management to discuss the results of civil/structural engineering assessments.

4.4 Civil/structural engineering personnel shall demonstrate a working level knowledge of problem analysis principles and the techniques necessary to identify problems, determine potential causes of problems, and identify corrective action(s).

Supporting Knowledge and/or Skills

- a. Describe and explain the application of problem analysis techniques including the following:
 - Root Cause Analysis
 - Causal Factor Analysis
 - Change Analysis
 - Barrier Analysis
 - Management Oversight Risk Tree Analysis

- b. Describe and explain the application of the following root cause analysis processes in the performance of occurrence investigations:
 - Event and causal factors charting
 - Root cause coding
 - Recommendation generation
 - c. Describe the following types of investigations and discuss an example of the application of each:
 - Type A
 - Type B
 - Type C
 - d. Compare and contrast immediate, short term, and long term actions taken as the result of a problem identification or an occurrence.
 - e. Given event and/or occurrence data, apply problem analysis techniques and identify the problems and how they could have been avoided.
 - f. Describe various data gathering techniques and the use of trending/history when analyzing problems.
 - g. Conduct an interview representative of one which would be conducted during an occurrence investigation.
- 4.5 Civil/structural engineering personnel shall demonstrate the ability to apply problem analysis techniques necessary to identify problems, determine potential causes of problems, and identify corrective action(s).**

Supporting Knowledge and/or Skills

- a. Given event and/or occurrence data, apply problem analysis techniques and identify the problems and how they could have been avoided.
- b. Participate in at least one Type A, B, or C investigation.
- c. Participate in at least one contractor or Department of Energy problem analysis and critique the results.
- d. Using data, interpret two fault tree analyses.

- e. Using contractor training procedures, applicable DOE Orders, and DOE Standard 1070-94, Guidelines for Evaluation of Nuclear Facility Training Programs, select three elements of the contractor training program and assess them for compliance and adequacy.

4.6 Civil/structural engineering personnel shall demonstrate the ability to act as the Department's subject matter experts for civil/structural engineering activities by routinely interacting with Federal, State, local and public stakeholder representatives during the oversight and management of civil/structural engineering programs.

Supporting Knowledge and/or Skills

- a. Discuss the roles and responsibilities of site and/or community advisory boards on civil/structural engineering issues as described in Public Law 92-463, October 6, 1972, and subsequent amendments, Federal Advisory Committee Act.
- b. Given data, discuss the Department of Energy's official position on three civil/structural engineering issues that impact one or more of the above segments (Federal, State, local, public stakeholders).
- c. Discuss the Freedom of Information Act and its impact on Department civil/structural engineering programs. State all security precautions to be taken with regard to relevant programs and the Freedom of Information Act.
- d. Under simulated conditions, demonstrate skill in dealing with the public and other stakeholders and when dealing with difficult people.
- e. Given civil/structural engineering-related program data, identify those portions of the data which are required to be communicated to external organizations and discuss any potential impacts on Department programs.
- f. Using techniques applicable to the situation, communicate with Headquarters Program Office representative(s); the Department's Legal representatives; contractor; State; and local officials.
- g. Given actual reports from the Defense Nuclear Facilities Safety Board (DNFSB), the Government Accounting Office (GAO), Tiger Teams, or any other entity external to civil/structural engineering, report on the applicability of these reports and any resulting implementation plans to Department civil/structural engineering programs.

EVALUATION REQUIREMENTS

The following requirements shall be met to complete the Department-wide Civil/Structural Engineering Functional Area Qualification Standard. The evaluation process identified below serves as a measurement tool for assessing whether the participants have acquired the technical competencies outlined in this Standard.

1. Documented completion of the Department-wide General Technical Base Qualification Standard in accordance with the requirements contained in that standard.
2. Documented completion of the competency requirements listed in this functional area qualification standard. Documentation of the successful completion of these competency requirements may be satisfied by a qualifying official using any of the following methods:
 - Documented evaluation of equivalencies
 - Written examination
 - Documented oral evaluation
 - Documented observation of performance

CONTINUING TRAINING AND PROFICIENCY REQUIREMENTS

Civil/Structural engineering personnel shall participate in an Office/facility/position-specific continuing training and qualification program that includes the following elements:

1. Technical education and/or training covering topics directly related to the duties and responsibilities of civil/structural engineering personnel as determined by line management. This may include courses and/or training provided by:
 - Department of Energy
 - Other Government agencies
 - Outside vendors
 - Educational institutions
2. Training covering topics that address identified deficiencies in the knowledge and/or skills of civil/structural engineering personnel.
3. Training in areas added to the Civil/Structural Engineering Functional Area Qualification Standard since initial qualification.
4. Specific continuing training requirements shall be documented in Individual Development Plans (IDPs).